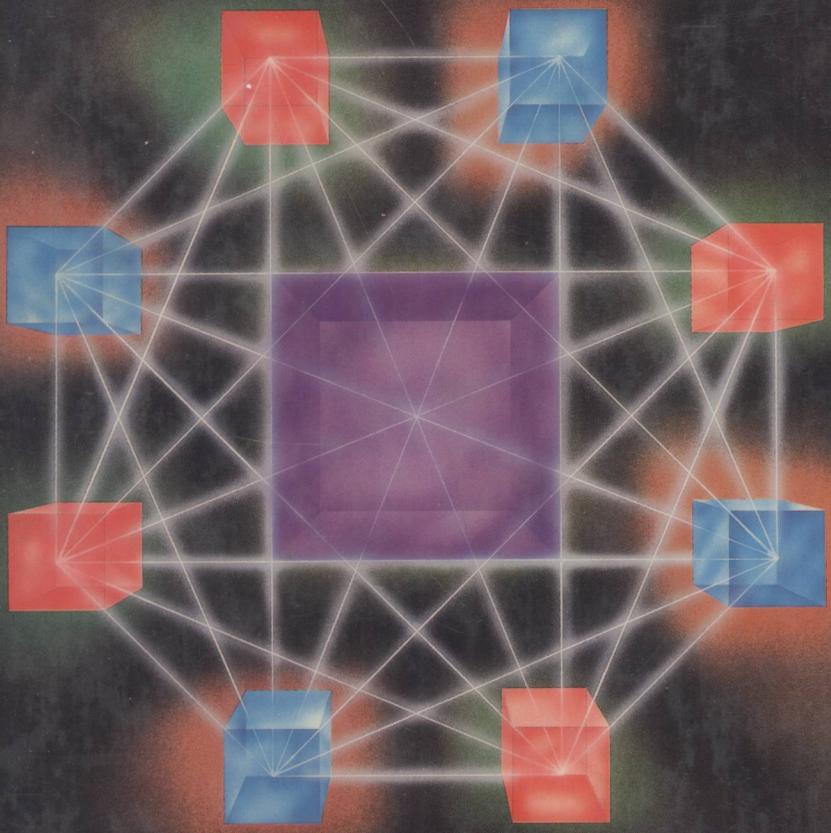
KEEPING THE LINK

ETHERNET INSTALLATION & MANAGEMENT



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Ethernet Installation and Management

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Love to Carol Eve Weingrod for enduring my long hours away from her.

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Preface

Data communications and Ethernet networks are often promoted as a "competitive weapon" and the means to solve computer problems and lower data processing expenses. Such approaches often misfire unless the network is carefully and intelligently administered. Networks are complex in all phases, from design to organization, from execution to daily operation and maintenance. A well-run network can match the promise of Ethernet and furnish an organization with a powerful strategy that outstrips competition.

This book presents the practical knowledge needed to design, build, grow, and maintain an Ethernet communication network for most vendor equipment, whether Apollo, Apple, Altos, Bridge, Convergent, DEC, DG, Hewlett-Packard, IBM, Sun, Xerox, or many others. This book is designed primarily to answer questions facing an Ethernet network manager and his or her team. The specifications of the IEEE 802 committee and the ISO network standard are used as a base for definition of key terms because most vendors try to adhere to these standards. Vendor Ethernet documentation is expanded and explained, and its practical ramifications are discussed. In addition, the nuts and bolts of planning for installation and cabling, capacity planning, physical maintenance, and statistical tracking are presented for the busy network administrator. Concise and specific illustrations and descriptions prepare even the novice for all stages of network administration, and clarify the ambiguous and sparse vendor Ethernet documentation.

This preface presents the organization of *Keeping the Link*. As an acknowledgment of the reader's limited time, Figure 1 illustrates the design and flow of the knowledge contained within this book.

Chapter 1 presents the network in light of its connective power as a strategic resource in today's competitive resource-limited environment and suggests how to make a persuasive argument for network technology.

Chapter 2 discusses in overview the benefits of networking and describes what Ethernet is, how it works, the variations in Ethernet protocols, and the types of problems that can be encountered in a production environment.

Chapter 3 presents a networking model and the variations in Ethernet. It describes the three standard baseband variations and the rationale supporting many organizations' selection of nonstandardized broadband.

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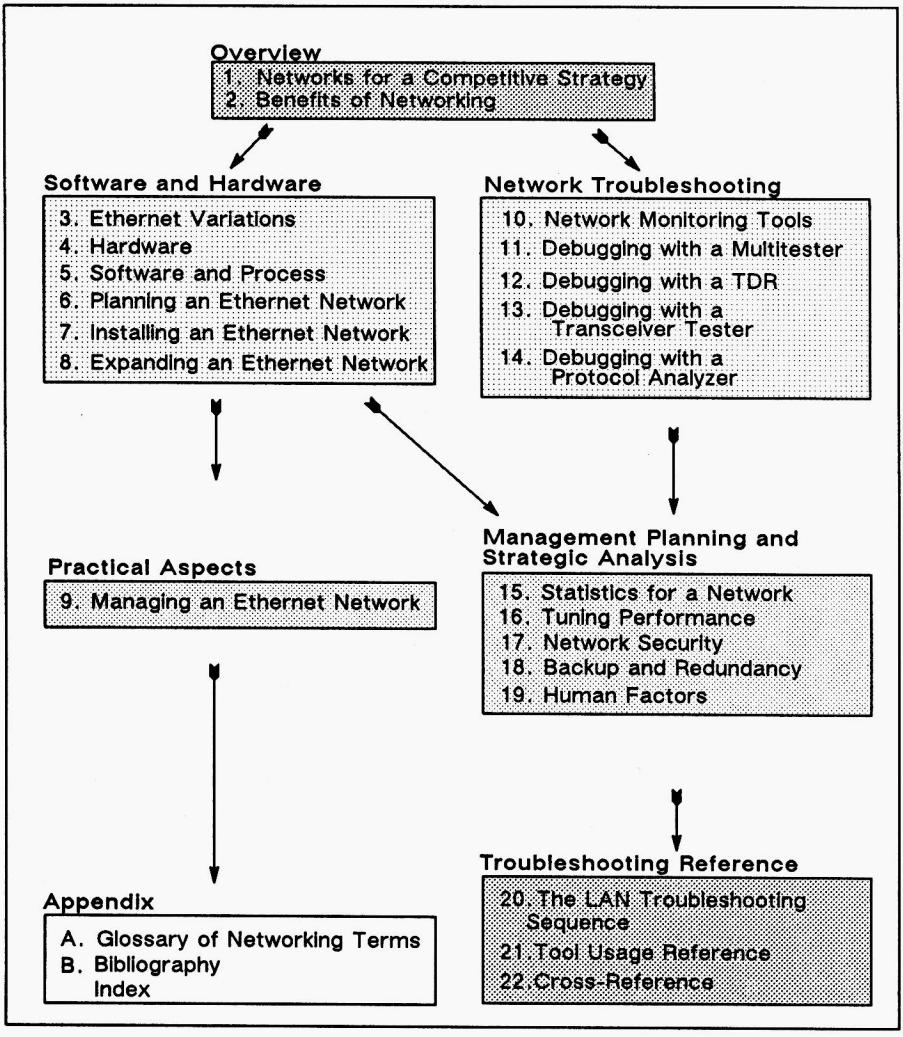

Figure 1 The organization of *Keeping the Link*.

Chapter 4 describes the hardware and the mechanical process of Ethernet. The components of an Ethernet network are described and illustrated to help the reader understand the ingenious simplicity of an Ethernet network.

Chapter 5 explains the Ethernet process. This includes the transmission methodology and the characteristic features of network-level software.

Chapter 6 details the planning procedures for the mechanical components of Ethernet networks, completing what spartan vendor instructions

omit. This chapter outlines those issues that an experienced network manager considers before building or expanding an Ethernet network.

Chapter 7 explains the installation procedures for the mechanical components of Ethernet networks, completing what spartan vendor instructions omit. This chapter suggests what steps an experienced network manager takes for testing and benchmarking a newly installed network.

Chapter 8 explains why bridges, fan-out units, gateways, and repeaters are necessary on a large Ethernet, and how these units are installed. Since organizational growth is likely to outstrip the capacity of any original network, bridges, fan-out units, gateways, and repeaters are also presented as solutions to overloaded networks.

Chapter 9 presents practical rules of thumb and suggestions for successfully using Ethernet. The formal IEEE and ISO specifications do little to explain the hows and whys of success and failure with Ethernet, therefore Chapter 9 concentrates on operational management.

Chapter 10 suggests practical tools that test, monitor, and analyze nework status. When the network fails there are various techniques to identify, locate, and repair problems. Some techniques are time-consuming or expensive and some require specialized tools like a multimeter, a time domain reflectometer, a transceiver tester, and a network analyzer. Because each of these tools is indispensable on a large, busy, or critical network, information on to how use them and interpret their results is presented in separate chapters complete with photographs, illustrations, and tables.

Chapter 11 details appropriate steps to verify the correct electrical operation of network hardware using a multimeter. This tool provides a first pass for testing a network. It is often the one tool available to a network manager to solve serious network failures.

Chapter 12 details the usage of a time domain reflectometer and the practical steps to check the conductivity and usability of network cable, connections and cable fittings, and to check for correct installation of taps and repeater hardware. This tool also provides a highly desirable method for benchmark cable installation.

Chapter 13 explains the operation of the transceiver tester, including how to connect and operate it, and how to interpret this tool's results.

Chapter 14 describes the necessity for the network protocol analyzer. The methodology for using this monitor to identify, locate, and isolate suspected network problems is presented in detail.

Chapter 15 calculates the statistics of Ethernet. Ethernet is a *carrier–sense multiple-access with collision detection* (CSMA/CD) process. This means Ethernet transmission is a random process and that many non-mechanical problems are inherently statistical. In order to understand why bottlenecks occur, why Ethernet collisions decrease performance, why a network can fail completely, the mathematics are analyzed and charted.

Chapter 16 builds upon the knowledge from the chapters on installation, configurations, network traffic, and statistics for the purpose of tuning network performance. It also discusses optimal planning, network loads, and alternative solutions for overloaded networks. This single chapter can be invaluable when network trouble occurs, when no solutions are self-evident, and when there appear to be no options for locating network failures.

Chapter 17 discusses security issues, explains why the networking model contains no reference to either data or physical security, why Ethernet is not secure, and what precautions can be taken to protect a network from outside prying and unauthorized access. Because Ethernet is a public network, packets are freely readable by any node workstation. As such, it is dependent on network software, specialized hardware, and judicious management procedures to maintain security.

Chapter 18 explains backup procedures and suggests what hardware, software, or operational procedures can be implemented to produce a nearly fault-tolerant network. Issues and redundancy for the important network services - files storage, printing, tape backup of network data, shutdown of failed segments - are discussed in this chapter.

Chapter 19 illustrates why trained and qualified people are an important resource for network administration. Ethernet depends on people with expertise and experience. Without knowledgeable people, the network will perform below capacity, cause severe operational problems, constrain organization growth, and in extreme cases, even fail to function.

Chapter 20 is a detailed troubleshooting manual that describes techniques to isolate hardware, software, and the common network overloading problems.

Chapter 21 summarizes the contents of this book with an Ethernet tool usage manual. This chapter supplies ideas and information on when to use the multimeter, the TDR, the transceiver tester, and a protocol analyzer to solve network problems.

Chapter 22 iconically describes the network components and then, using tables with four different formats, matches symptoms of common network problems with the possible causes. This information is not available cross-referenced, nor completely accessible from other sources including vendor documentation or the IEEE Ethernet specifications.

Chapter 23 is a glossary with local area network and Ethernet terms defined and cross-referenced by the all-too-common acronyms.

Symbols Used in this Book

Segment Repeater

Segment Bridge

Segment Gateway

Coaxial Tap and Transceiver (MAU)

Transceiver Drop Cable (AUI)

Network Node

Designated Network Node

Cheapernet or Thinnet Coaxial Cable

Ethernet Coaxial Cable

End Connector

End Connector with Terminator

End Connectors with Barrel Connector

Contents

Part 1

Overview

This section presents an overview of Ethernet networking. The first chapter presents the network in light of its connective power as a strategic resource in today's competitive resource-limited environment and suggests how to make a persuasive argument for network technology. Chapter 2 discusses in overview the benefits of networking and describes what Ethernet is, how it works, the variations in Ethernet protocols, and the types of problems that can be encountered in a production environment.

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Chapter 1

Networks for Competitive Strategy

The complex business environment is challenging organizations to discover new ways to gain competitive advantages. In addition to the traditional physical and monetary assets such as equipment, buildings, and cash reserves, an organization has information and networking assets. Although information management is better understood by most private-sector business administrators through the context of the *value chain, market dynamics, distribution channel,* and *price points* than it is through the context of computer technology, networking, management of information systems, or data processing, an organization also can leverage the creative uses of information and networking technology for strategic benefit. The aim of networking strategies is to move an organization to its potential while locking out with aggressive information systems its competitors and providing a *sustainable competitive advantage* which those competitors will find difficult to copy.

There is a continuum of complexity with computer and communication technology. For a small company, networking just the inventory system might be considered a strategic advantage, while a larger company might implement a network to serve all workers at all locations. There is a learning curve attached to information and communication technologies. Even while the key to success is to learn faster and implement sooner than competition, the networking trend is continuing. Each success raises the ante; more complex and intuitive applications of networking are required to sustain a competitive advantage.

This proliferating new communications technology has reshaped the marketplace because it has altered the competitive game for all organizations. Communications have become integral to most computer and business activities. Some organizations will fail to recognize the available opportunities, and others will fail to recognize how to adapt them to the new possibilities in their strategic planning. Technological changes improve the efficiency and enhance implementation of communication. Networking, in particular, is a sophisticated and deliberate strategy that can improve profits, productivity, market share, product distribution, and work environments by facilitating quick decisions, improving information flow and accuracy, and communicating such information and decisions rapidly to those who would benefit from them.

If information and networking technology appear to be strategic solutions, this technology must be applied with foresight, forethought, and a critical understanding of the market. Clearly, the risk is not only to those who try new technology with its potential for clumsy and inefficient results; too many organizations have learned the painful consequences of limiting the reach and coverage of information exchange. The risk is also to those who watch and wait while others succeed first. With the accelerating pace of change, the complexity of technology, and the increasing sophistication of those applying networking technology, there is little ascertainable difference between strategic initiative and a "hare-brained" idea; for a strategy to be effective it must be implemented correctly before the competition understands what that strategy is. Of necessity, effective strategies precede the complete understanding of the applicable technology.

Advantages of Networks

Networks yield significant advantages that can overwhelm a competitor. Networking power can provide better service with fewer resources. It can also provide a medium in a research and development environment for cross-fertilization of ideas. Networking can streamline processes inherently slow or inherently fragile, and automate these processes for higher integrity. While the financial planner is often severely challenged to quantify these benefits in terms acceptable to stockholders, trustees, and bankers, it is proven that networks do generate cost-effective benefits, create significant economies of scale, boost worker productivity, and create unanticipated and imaginative results. Networks thus offer an applicable competitive strategy. The competitive advantages created through networking are summarized in Figure 1.1.

- Higher worker productivity
- Integration of process and information
- Lower installation cost per device or user
- Sharing of expensive resources
- Consolidation of scarce resources
- Creation of critical channels for communications
- Increases in the speed of contact and transactions
- Global access to information
- Higher resource utilization
- R&D discovery
- Interaction between information workers

Figure 1.1 Networks provide competitive advantages over mainframes.

It has been known for years that data processing is a viable competitive tool. Such systems have generated information that managers have applied

to pare costs, simplify product design, identify excessive or expensive procedures, locate cost variances, reduce inventory, target customer preferences, and provide strategic product information required to capture market segment. Data processing is most useful in capturing cost, inventory, pricing, and production information. More sophisticated uses of computer networking power have been integrated directly into marketed products and services, and these products and services sell better because of that informational content. While computer-related products—hardware, software, information, publishing, or R&D—are often presented as products and services that strategically benefit from computer networking, many "unlikely" products and services benefit as well by providing wider information exchange and faster response, and by opening new areas and new sources. Examples include airline flights, hospital supplies, air conditioners, and cosmetics.

Networks Create Monopolies

TWA built the APOLLO flight reservation system while American Airlines constructed the SABRE network. These two reservation systems were integrated into the travel agent's selling cycle. They surpassed expectations because they offered precise and readily available information about flight times, seating availability on a selected flight, and connecting links. Once these flight reservations had widely replaced the mediocre travel agent, reinforced the knowledgeable agent, and circumvented other information channels, these systems monopolized the purchasing decisions by preventing travelers from seeing alternatives to TWA and American flights.

Preprinted Flight Schedules	Online Reservation System
Determine Traveler Source and Destination	Determine Traveler Source and Destination
Locate Flight Options: direct flights indirect flights connecting flights Repeat for Each Airline Confirm with Airline Determine Seating Availability Determine Pricing	Query Terminal for: flight times seating availability cost flight plan
Select Option Confirm with Airline Check Alternatives Repeat if Error	Select Option Confirm with Airline

Figure 1.2 Flight reservation purchasing process.

Cost information was filtered at the time of the presentation to the benefit of the airlines and detriment of the traveler. The reservation system bypassed alternative purchasing processes by providing time-critical information otherwise unavailable to the true decision maker, the agent, not the traveler. Figure 1.2 contrasts the functional simplicity of the flight reservation system with more complicated preprinted information schedules.

Networks Focus Distribution Channels

Hospital Supply Corporation of America (HSC) supplied hospitals with free video display terminals and connections to its headquarters. Not only were the connections mechanical, but also administrative. This computer link-up provided hospitals with information on both hospital and HSC inventory levels, product prices, alternative products, and an instantaneous ordering process with known delivery times. Hospitals were able to reduce in-house inventory, pare costs, and uniformly locate better products at better prices.

HSC also was able to plan its own inventory levels with more efficiency and analyze what hospitals needed and when, thus offering automatic deliveries of basic commodities. Competitors of HSC who tried to install terminals for their inventory lines found desk top space lacking, users unwilling to learn a new computer ordering system, and hospital administrations unwilling to cover training costs for small improvements offered by HSC competitors. Once the ordering system was installed and proven successful, competitors lacked a sufficient infrastructure to compete. When these systems were integrated into the daily workings of the hospitals and buying economies were passed along to them, then HSC raised prices and substituted higher priced products for commodity items. This yielded a stunning price advantage for HSC, an advantage that is both legal and sustainable.The influence of the computer purchasing systems in the buying process is presented in Figure 1.3.

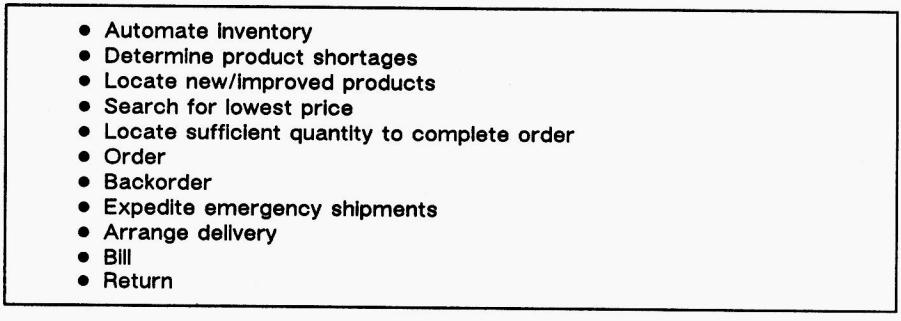

Figure 1.3 The influence of computerized purchasing.

Networks Improve Information Flow

Fedders, Incorporated, which supplies environmental cooling and heating systems for large commercial and industrial buildings, gave large customers personal computers with software. Architects and building engineers use this software to configure the cooling and heating needs for a planned building. The building engineer transmits this information to Fedders offices for processing, and naturally, the results specify selected Fedders components. Not only are the architects hard-pressed to gather similar specifications from competitors, but Fedders gains early knowledge of building plans. As a result, Fedders vigorously sells components to the contractors before the competition even knows about the proposed building and promotes architectural specification of Fedders equipment at the design stage. Competitors of Fedders, like competitors of HSC, find themselves locked out of similar strategies because of the reluctance of architects to learn and simultaneously use a second and not necessarily superior computer product. Figure 1.4 positions this critical influence of a computer on the architect's decision-making cycle.

- Accept plan
- Design building per architect's concept
- Configure cooling and heating systems
- Determine equipment components and prices
- Search for lowest price
- Accept configuration/redesign
- Verify qualities and performance by vendor
- Select vendor
- Arrange delivery

Figure 1.4 The influence of computers on the architectural design cycle.

Networks Add Value to Products

Cosmetic companies are using computers to learn about potential customers from a data entry questionnaire process at department store counters. The questionnaire seeks such information as skin color and tone, skin dryness, skin problems, specific cosmetic color preferences, clothes style preference, and lifestyle. An "expert system," a computer program that simulates the skills of an expert cosmetologist, generates a report containing details about, and categorizing problems facing, the customer. A salesperson can use this focused and highly personalized information to make a good sale and suggest specific products for the customer.

Often the report contains specific instructions for the customer on product usage. This report sells products more successfully than other methods because the products are bundled into proper combinations and

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